



# Medial patellofemoral ligament reconstruction fails to correct mild patella alta in cases of patellofemoral instability—a case-control study

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## Abstract

**Purpose** Medial patellofemoral ligament reconstruction (MPFL-R) is the gold standard in patella soft tissue surgery for patellofemoral instability. Although claimed, recent reports indicate that MPFL-R may fail to distalize the patella in mild cases of patella alta. The present study is a retrospective case-control study to compare radiographic patella height between MPFL-R and historical Insall's proximal realignment (IPR) pre- and post-operatively with respect to distalization and assess redislocation rates at a mid-term follow-up.

**Methods** Sixty-four patients were age/sex matched (1:1), yielding 32 patients for group 1 MPFL-R (cases) and 32 patients for group 2 IPR (controls). Insall-Salvati, Blackburne-Peel and Caton-Deschamps indices were analyzed for differences pre- and post-operatively. An additional inter-rater reliability analysis was performed by means of intra-class correlation (ICC). Redislocation rates were considered as treatment failures in this study.

**Results** ICC was excellent for all three patella indices. MPFL-R failed to show significant differences if compared to IPR with respect to distalization in mild stages of patella alta. Moreover, redislocation rates significantly favored MPFL-R (3.1%) over IPR (12.5%;  $p < 0.0001$ ).

**Conclusions** MPFL-R has become a popular option to restore native patellofemoral biomechanics after ligament rupture. However, the procedure's potential to correct concomitant patella alta should not be overestimated and indications considered carefully.

**Keywords** Medial patellofemoral ligament · Proximal realignment · Patella alta · Patella height indices

## Introduction

Various predictors for primary and repeated patellar dislocation have been identified until today, among them is patella alta as a prominent and easy to assess entity. Even a first tool for risk stratification of redislocation has been developed recently, combining age, contralateral instability, trochlear dysplasia, patella height, tuberositas tibia trochlear groove (TT-TG) distance and patella tilt in one clinically applicable score

[1]. Treatment options should be considered thoroughly, to fit patients' needs as close as possible. The “menu à la carte” concept according to the Lyon school of knee surgery largely prevailed in international literature during recent years [2]. However, in a vast majority of cases, individual anatomical factors adding to dislocation like TT-TG distance or trochlear dysplasia may not be pronounced in a way that absolutely justifies bony corrective procedures [3]. For the TT-TG distance, a dependency on other bodily parameters like leg length and joint size has been demonstrated recently, complicating a reliable use for either surgical indication or post-operative follow-up [4]. Those cases of primary dislocation are most often treated by stand-alone soft tissue surgery. Among those procedures, we find the historical, but still widely used Insall's proximal realignment (IPR) [5] as well as modern anatomic reconstruction of the medial patellofemoral ligament (MPFL-R) [6]. In contrast to IPR, anatomic MPFL-R is regarded for its effect on patella height and has even been proposed as a treatment option for combined patella alta and patellofemoral instability [7].

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The present study compares radiographic patella height between both soft tissue procedures pre- and post-operatively with respect to distalization and assesses redislocation rates at a mid-term follow-up. It was hypothesized that neither stand-alone procedure would show an impact on mild stages of patella height. Secondly, it was hypothesized that redislocation rates would be lower in the MPFL-R group as a result of restoration of native anatomy and biomechanics.

## Methods

The study was approved by the local institutional review board (study no. 371/17) and conducted in accordance with the 1964 Declaration of Helsinki and its later amendments.

## Patients

The present work is a retrospective case-control study of patients that underwent either stand-alone anatomical double-bundle MPFL-R (case) or IPR (control) for patellofemoral instability with concomitant mild patella alta. Since IPR is regarded not to distalize the patella and both procedures are considered mere soft tissue surgery, it serves as a control to mimic all attributes of correction besides anatomic reconstruction of the MPFL. Skeletally mature patients (age > 17 years) with a history of primary or recurrent (> 1) patella dislocation and patella alta as measured by patella height indices were considered eligible. Besides plain radiographs, routine pre-operative workup included native magnetic resonance imaging (MRI) of the involved knee to rule out cartilage lesions, as well as rotational profile computed tomography (CT) scans to evaluate possible torsional deformities of the lower extremity and calculate the TT-TG distance. Combination of MRI and CT scans allowed to assess trochlear geometry and rule out dysplasia. Additional long-leg standing plain radiographs were only taken if leg axis deviation was suspected clinically or based on the plain radiographs. The records of 145 patients that were treated between December 2010 and December 2015 at our department were reviewed. Exclusion criteria are depicted in Table 1. A total of 81 patients met the inclusion criteria, and 64 could be age/sex matched in a 1:1 fashion, yielding 32 patients for group 1 (MPFL-R) and 32 patients for group 2 (IPR). Seven had to be excluded because of missing or incomplete radiographic data, four had to be excluded because of concomitant trochlear dysplasia, and two each had to be excluded because of concomitant flake fractures, torsional deformities or leg axis deviations. Furthermore, four of the above-mentioned patients additionally suffered reported hyperlaxity which was seen as another exclusion criterion. Epidemiological and radiographic data pre- and post-operatively as well as reported redislocations/failures at the latest available follow-up were retrieved from the clinical content management system. Plain radiographs

**Table 1** Exclusion criteria for standalone MPFL-R or IPR groups

Incomplete clinical records
Incomplete radiographic records
Previous patella surgery
Hyperlaxity (Beighton score > 5/9)
Flake fractures of the patella/trochlea
Trochlear dysplasia (> Dejour type A)
Torsional deformities or TT-TG distance > 20 mm
Leg axis deviations > 5° in frontal plane

included knee standing anterior-posterior (a.p.), horizontal beam lateral and patella skyline views at 30° of knee flexion pre- and post-operatively.

## Surgery

Anatomic double-bundle MPFL-R was performed according to Schoettle et al. using the autologous ipsilateral gracilis tendon [6]. Intra-operative fluoroscopy was used to identify the Schoettle point on the medial femoral epicondyle to ensure isometricity of the tendon graft. After preparation and identification of the correct anatomical layer in between retinacular layers, a rim was created at the outermost aspect of the medial patellar facet. Hence, drilling was performed and two 3.5-mm tenodesis suture anchors (SwiveLock®, Arthrex Inc., Naples, FL, USA) were used to fix the graft in the previously prepared rim (patella first). After manual tensioning, both free ends of the graft were shuttled through the retinacular layers into the femoral tunnel and aperture fixation was performed in 20° of knee flexion using a bioresorbable screw (Arthrex Inc., Naples, FL, USA) after manual assessment of patellar tracking (femur second).

IPR was performed in a modified technique according to Rudert et al. [5]. The distal lateral extensor retinaculum was split in a proximal direction together with the merging fibers of the iliotibial tract. Secondly, a lengthwise incision from the medial portion of the distal quadriceps tendon is made passing the medial patella margin and ending in the proximal portion of the patella tendon. After a careful preparation and complete visualization of its medial margin, the patella was slipped underneath the musculofibrous flap formed by the vastus medialis and the medial extensor retinaculum. U-sutures were then used to attach this tissue in a laterodistal position (relative to its previous one) to the ventral tendinous part of the patella, changing the lever arms and force vectors to the patella.

All patients were allowed immediate full weight bearing post-operatively and fitted with a brace for a duration of 6 weeks with knee flexion being limited to 30° post-operatively, increasing to 60° after two weeks and 90° after four weeks. Physical therapy focused on strengthening of quadriceps muscles and improvement of walking gait.

## Radiographic evaluation

Patella height index was assessed according to Insall-Salvati, Blackburne-Peel and Caton-Deschamps on knee horizontal beam lateral radiographs [8, 9]. Patella alta was considered mild around a Caton-Deschamps index of 1.20 and severe if  $> 1.40$  [10]. All above-mentioned radiographic indices were measured in pre- and post-operative radiographs using Agfa Impax EE (Agfa HealthCare GmbH, Bonn, Germany) as depicted in Fig. 1. An additional inter-rater reliability analysis of patella height indices measured by three blinded independent orthopaedic surgeons (PPR, MDW, CJ) in the same fashion was performed in eight randomly selected cases for both groups, respectively.

## Statistical analysis

Normality tests were performed for both groups, and descriptive statistics was calculated for all available data. In case of symmetrical distribution, paired *t* tests were used to directly compare both matched groups. Moreover, inter-rater reliability analysis was performed in a defined sample of cases via intra-class correlation (ICC) using IBM SPSS Statistics 24.0 (IBM Corp., Armonk, NY, USA). Data are given as means  $\pm$  standard deviation (SD) and ranges if not indicated otherwise. The level of significance was set at  $p < 0.05$ .

## Results

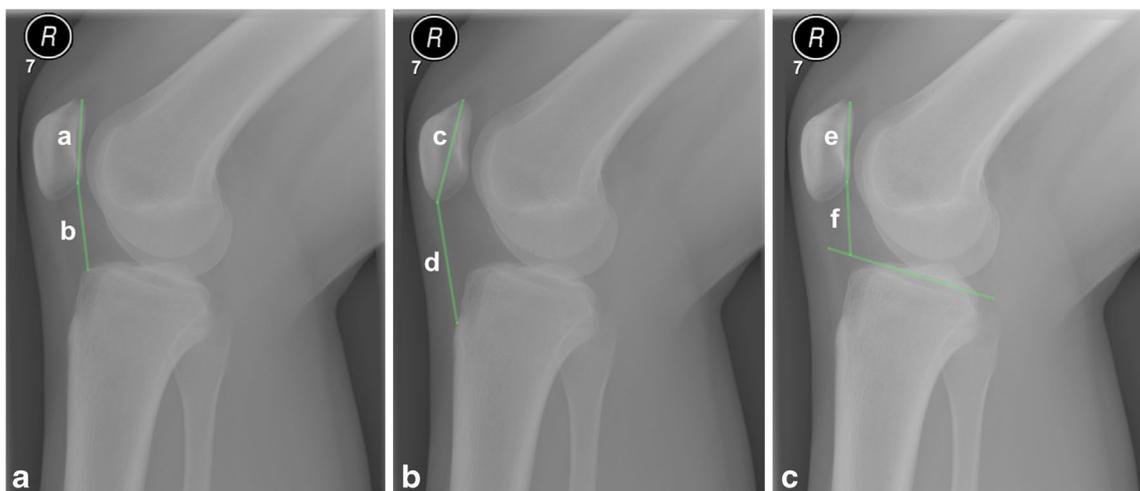
Epidemiological patient characteristics are depicted in Table 2. No intra-operative complications could be recorded. Post-operative ( $< 4$  weeks after surgery) complications included one hematoma (3.1%) in the MPFL-R and two (6.3%)

hematomas in the IPR group, with none of them requiring surgical evacuation. Mean hospitalization after surgery was  $3 \pm 1$  day (range 2–7 days) in the MPFL-R and  $3 \pm 1$  day (range 2–6 days) in the IPR group. Range of motion pre- and post-operatively did not show significant differences between both groups. All patients returned to their previous levels of activity. Redislocation rates at a mean of  $49 \pm 8$  month follow-up for MPFL-R ( $n = 1$ ; 3.1%) and a mean of  $52 \pm 7$  months for IPR ( $n = 4$ ; 12.5%) were significantly different between both groups ( $p < 0.0001$ ).

Pre- and post-operative radiographic measurements are shown in Table 3. Femoral tunnels of the MPFL-R cases were within a  $2 \pm 2$ -mm range of the supposed Schoettle point as checked in post-operative horizontal lateral beam radiographs. Inter-rater reliability was excellent for all used patella height indices with ICC = 0.88 for Insall-Salvati index, ICC = 0.82 for Blackburne-Peel index and ICC = 0.81 for Caton-Deschamps index. Anatomic double-bundle MPFL-R failed to significantly distalize the patella in mild stages of patella alta comparing pre- and post-operative measurements. Furthermore, MPFL-R did not show a significant superiority with respect to patella distalization as compared to IPR.

## Discussion

The most important finding of the present study is that anatomic double-bundle MPFL-R failed to significantly distalize the patella in mild stages of patella alta as compared to IPR. Despite that, significantly different redislocation rates still indicate MPFL-R's superiority over IPR in clinical outcome. Thus, both initial hypotheses were accepted. Besides the well proven fact that MPFL-R achieves anatomic and isometric reconstruction of the native ligamentous structures of the



**Fig. 1** Patella height indices. **a** Caton-Deschamps index: ratio (b/a) anterior aspect of tibial plateau to inferior point of patella back (b) and patella back inferior to superior (a). **b** Insall-Salvati index: ratio (d/c) upper part of tibial tubercle to inferior pole of patella (d) and inferior

pole of patella to superior pole. **c** Blackburne-Peel index: ratio (f/e) tangential line to tibial plateau connecting to line facing anterior aspect of tibial plateau to inferior point of patella back (f) and patella back inferior to superior (e)

**Table 2** Epidemiological and injury characteristics of MPFL-R and IPR groups

Variable	MPFL-R	IPR	<i>p</i>
Age (year)	28.7 ± 9.6	28.9 ± 6.9	n.s.
Sex f/m ( <i>n</i> )	19/13	19/13	n.s.
Weight (kg)	73.45 ± 11.65	70.34 ± 11.67	n.s.
Height (m)	1.73 ± 0.11	1.73 ± 0.12	n.s.
BMI (kg/m <sup>2</sup> )	24.80 ± 4.27	23.88 ± 4.93	n.s.
Injury mechanism ( <i>n</i> )			
• Traumatic	22	21	n.s.
• Spontaneous	10	11	n.s.
Dislocation frequency ( <i>n</i> )			
• Primary	12	12	n.s.
• Repeated	20	20	n.s.

n.s., not significant

medial knee retinaculum, it is also frequently recommended because of its attributed decreasing effect on patella height [6].

Patella alta is an accepted predictor for primary and recurrent patella dislocation that has to be considered in the planning of any surgical patella procedure [1, 11]. Besides that, its role in patellofemoral instability remains unclear to date. It has not yet been clarified if MPFL rupture precedes or adds to the state of patella alta or if it is the ultimate triggering cause for patellofemoral instability, eventually leading to MPFL rupture itself [12, 13]. Investigations remain challenging, as hardly available radiographic data of the pre-injured states would be needed to prove this concept in an injured cohort. However, the absolute impact of an MPFL rupture on patella height appears to be limited through the much stronger influence of the patella tendon as a secondary restraint [14]. Besides that, it is not only the secondary restraint that plays a role in this problem, but also other factors like femoral tunnel (mal-)placement [11, 15].

Only recently, biomechanical evidence emerged that the effect of patella distalization in MPFL-R may be dependent on the stage of patella alta. While very high stages of patella alta (Caton-Deschamps index = 1.40) showed very low restraining forces to the patella, the ones that occurred in mild stages of patella alta (Caton-Deschamps index = 1.20) were significantly higher. Thus, it has to be considered easier to

overcome the lower restraining forces of a severe patella alta, before the patella is recentred and contained in the patellofemoral joint again, than to overcome the much higher forces of an already contained patella in mild patella alta. As double-bundle MPFL-R is limited in its restraining strength due to the nature of the procedure and the graft, it appears to be clear that distalization potential strongly depends on restraining forces of the surrounding soft tissues and the contact pressures in the patellofemoral joint. Moreover, the patella height and, thus, patella alta have to be considered a dynamic condition without clearly defining age/sex ranges until today. Different approaches with varying techniques have been made, to define these borders for the Caton-Deschamps index and others, and there is still an ongoing debate in present literature [8, 9, 16]. Recently, a modified Caton-Deschamps index has been proposed, specifically for cases of total knee arthroplasty, since there are a lot of possible confounders, once bony morphology or alignment are changed [17, 18]. For this particular reason, patella alta has to be regarded as a highly variable and individual predictor for patella (re-)dislocation if it comes to absolute measurement values.

Clinically, Fabricant et al. reported a significant distalization of the patella in severe patella alta (mean Caton-Deschamps index = 1.39 ± 0.25) with modified anatomic MPFL-R in children [7]. These findings were, in parts, also supported by another recent study with a mid-term follow-up in children [19]. This is in line with the proposed concept that severe stages of patella alta might be easier to distalize because of the much lesser restraints and patellofemoral contact pressures working antagonistic in these cases [10]. Moreover, the anatomic concept of MPFL-R is supported by the present findings, as redislocation rates are also in line with the literature for both groups [20].

Limitations of the present study are its overall low number of cases, which is, however, in line with most other comparable reports in the literature. Larger scale cohorts or even randomized controlled trials on this topic would be needed to clarify the research question in an adequate way. Despite this demand, the use of a historic control group with IPR is valuable in this case as it enables us to reconsider our practice and the quick adaptation of MPFL-R to the disadvantage of other established techniques during the recent decade. As in other clinical studies, it remains difficult to attribute that a quantifiable effect of

**Table 3** Pre- and post-operative radiographic measurements of MPFL-R and IPR groups

Variable	MPFL-R			IPR		
	Pre	Post	<i>p</i>	Pre	Post	<i>p</i>
Caton-Deschamps index	1.28 ± 0.18	1.23 ± 0.15	n.s.	1.28 ± 0.16	1.29 ± 0.15	n.s.
Insall-Salvati index	1.27 ± 0.16	1.28 ± 0.17	n.s.	1.23 ± 0.18	1.23 ± 0.14	n.s.
Blackburne-Peel index	0.79 ± 0.22	0.86 ± 0.23	n.s.	0.93 ± 0.22	0.96 ± 0.23	n.s.

n.s., not significant

cranialization to the previous MPFL rupture and chronicity remains unclear [7].

In conclusion, MPFL-R has become a popular option to restore native patellofemoral biomechanics after ligament rupture. However, the procedure's potential to correct concomitant patella alta—especially in mild stages—should not be overestimated, and indications should be considered carefully.

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### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflicts of interest.

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